

10. (Amended) A semiconductor device comprising a semiconductor substrate, and aluminum conductors formed on a side of a main face of the substrate which aluminum conductors comprise aluminum as a main constituent thereof, said aluminum conductors having at least one area in which conductor spacing is not more than 0.4 μm , a film adjacent to said aluminum conductors which adjacent film comprises one kind selected from the group consisting of ruthenium, platinum and iridium as main constituent thereof, said aluminum conductors containing copper, wherein said aluminum conductors contain nickel not less than 0.02 at.% but not more than 1 at.%.

In the Abstract:

Please amend and replace the abstract provided on a separate sheet herewith.

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This amendment is in response to the Office Action dated January 11, 2002. Appreciation is expressed to the Examiner for the allowance of claims 1-4 and the indication of allowable subject matter in claim 10 if rewritten into independent form to incorporate the subject matter of its parent claim 9.

By the present amendment, the title, specification and

abstract have each been amended to respond to the points of objection raised in the Office Action. Accordingly, removal of these objections is respectfully requested.

With regard to the claims, rejected claims 5-9 and 11 have been cancelled, without prejudice to the applicants' right to file these claims by way of a divisional application. Claim 10 has been rewritten into independent form to place it in condition for allowance, and claims 1, 2 and 4 have each been amended to improve the grammatical expression in these claims. It is noted that no substantive amendments have been made to any of claims 1-4 or 10. Accordingly, in light of the indication of allowable subject matter in these claims, reconsideration and allowance of this application with the remaining claims 1-4 and 10 is respectfully requested.

Attached hereto is a marked-up version of the changes made to the title, specification, claims and abstract by the current amendment. The attached page is captioned "Version with markings to show changes made."

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of, either by telephone discussion or by personal interview, the Examiner is invited to contact applicants' undersigned attorney at the number indicated below.

To the extent necessary, the applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this

paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, Deposit Account No. 01-2135 (500.38949X00).

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By 

Gregory E. Montone
Registration No. 28,141

GEM/kd
703/312-6600

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Title:

SEMICONDUCTOR DEVICE HAVING ALUMINUM CONDUCTORS

In the Specification:

Page 1, paragraph beginning at line 7, has been amended as indicated below:

In recent years, due to the miniaturization of semiconductor devices, the width of metal conductor tends to become small. Thus, to prevent an aluminum conductor from being broken due to migration and to prevent hillock from occurring due to the migration, there has been generally used a method of adding copper of about 0.5% in aluminum used for the aluminum conductor. However, the spacing of metal conductor portions as well as the metal conductor width tends to also become small. Thus, if any precipitate containing copper exists between two metal conductor portions, it becomes the cause of short fault. To address this problem, it is proposed, in JP-A-8-186175 [and etc.], to adopt a method comprising the steps of forming aluminum film at a high temperature so that copper may be dissolved in aluminum, and quenching the aluminum film so that the copper may be prevented from being precipitated during the cooling thereof.

Page 2, paragraph beginning at line 11, has been amended as indicated below:

The precipitation of copper regarding the aluminum conductor is found to proceed due to the diffusion of copper atoms existing in crystal grain boundaries and in crystal grains. Thus, in order to prevent the precipitation from occurring, it is necessary to suppress the diffusion of the copper atoms existing in the aluminum conductor. After performing intensive [researches] research for obtaining means for suppressing the diffusion of the copper atoms, the inventors of the invention have discovered that, by adding in the aluminum conductor an additive which suppresses the diffusion of copper, the precipitation can be prevented.

In the Claims:

Please cancel claims 5-9, 11 without prejudice.

Please amend claim 1, 2, 4 and 10 as follows:

1. (Amended) A semiconductor device comprising a semiconductor substrate, and aluminum conductors formed on a side of a main face of the substrate which aluminum conductors [comprises] comprise aluminum as a main constituent thereof, said aluminum conductors containing copper and nickel.

2. (Amended) A semiconductor device according to claim 1, wherein said aluminum conductors have at least one area in which conductor spacing is not more than 0.4 μm .

4. (Amended) A semiconductor device comprising a semiconductor substrate, and aluminum conductors formed on a side of a main face of the substrate which aluminum conductors comprise aluminum as a main constituent thereof, a film adjacent to said aluminum conductors which adjacent film comprises titanium or titanium nitride as a main constituent thereof, said aluminum conductors containing copper and nickel.

10. (Amended) A semiconductor device comprising a semiconductor substrate, and aluminum conductors formed on a side of a main face of the substrate which aluminum conductors comprise aluminum as a main constituent thereof, said aluminum conductors having at least one area in which conductor spacing is not more than 0.4 μm , a film adjacent to said aluminum conductors which adjacent film comprises one kind selected from the group consisting of ruthenium, platinum and iridium as main constituent thereof, said aluminum conductors containing copper [according to claim 9], wherein said aluminum conductors contain nickel not less than 0.02 at.% but not more than 1 at.%.

In the Abstract:

The abstract has been amended as follows:

[There is provided a semiconductor device having high reliability, high yield, and such a interconnection structure as short hardly occurs. The] A semiconductor device [comprises] is provided which includes a semiconductor substrate, metal conductors formed on a side of a main face of the substrate, which metal conductors contain aluminum as a main constituent thereof, and copper as an additive element, the metal conductors being made to contain such an element as to suppress the precipitation of copper or being made to have such a film adjacent to the metal conductor as to suppress the precipitation of copper or being made to have such a film adjacent to the metal conductor as to suppress the precipitation of copper.

In the Abstract:

A semiconductor device is provided which includes a semiconductor substrate, metal conductors formed on a side of a main face of the substrate, which metal conductors contain aluminum as a main constituent thereof, and copper as an additive element, the metal conductors being made to contain such an element as to suppress the precipitation of copper or being made to have such a film adjacent to the metal conductor as to suppress the precipitation of copper or being made to have such a film adjacent to the metal conductor as to suppress the precipitation of copper.

Ab